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Original Communication

Dental age estimation from the developmental stage of the third molars in Iranian population

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ABSTRACT

A sharp increase in forensic age estimation of living persons has been observed in recent years. However, ethnic populations residing in different countries have been insufficiently analyzed. The aim of this study was to achieve a referral database and regression equations for dental age estimation of unaccompanied minors of Iran nationality. A total of 1200 orthopantomograms were collected from original Iran and equally divided in age categories between 10 and 27 years. On the radiographs, the developmental stage of the third molars was scored applying a Demirjian et al. scoring technique. Inter- and intra-observer reliabilities were tested using kappa statistics. Correlation between the scores of all four wisdom maxillary and mandibular third molars teeth and left/right symmetry were evaluated with spearman correlation coefficient. Student's *t*-test on asymmetry was performed and regression formulas were calculated. The present database was the first to assemble third molar developmental scores on radiographs of Iran individuals and provided more appropriate dental age estimation of unaccompanied Iran minors. To enhance the accuracy of forensic age estimates based on third molars mineralization, the use of population-specific standards is recommended.

1. Introduction

Teeth represent useful material for age estimation. In childhood, the observation of the dentition status results in highly accurate age assessment. However, this accuracy decreases simultaneously with the completion of a person's dental development.[1] The development of each individual can be affected by genetic, nutritional, climate, hormonal, and environmental factors.[2,3]

It has been reported that dental mineralization is less affected by external factors as compared to bone mineralization.[4] In addition to its clinical importance, the radiographic diagnosis may have possible medico-legal implications, because it is one of the parameters proposed to determine the age of undocumented youths.[5,6] In these cases the assistance of a specialist in forensic dentistry may be required to help establish the biological age of the unidentified or undocumented person. Therefore, both in clinical settings and in the specific field of forensic medicine, there is a growing demand by the courts for appropriate medical tests aimed at estimating the approximate age of undocumented, presumed minors. Dental development correlates with different morphological stages of mineralization that can be observed in X-rays, comprises a more uniform and gradual set of changes than eruption, and may be less influenced by external factors (such as malnutrition, disease, and mental stress) than other measurable criteria of maturity.[4]

Numerous studies have been developed to estimate dental age.[3,5–10] When most of the teeth are in the process of completing apical formation, dental age estimation becomes more difficult. The only teeth still growing after that age are the third molars, which are highly variable in their pattern of formation: agenesis is frequent, and the age of complete mineralization varies widely.[8–12] Different radiographical scoring methods have been proposed, but in this study, Demirijian et al., [11] scoring method was used for compared to other populations.[10–12] Although this variability may mostly relate to population differences, other factors, such as sex, age, and degree of dental maturation of the individual in different samples may also play a major role.[2,5,6,13–31]

In the past, several studies have been undertaken in different populations to explore the usefulness of the third molar as a reliable age indicator.[5,10–31] These studies show that dental development varies slightly between different populations, making population-specific studies necessary. Recently, for different ethnic groups, numerous reports have been published on the evaluation of dentition development, and further studies were warranted for Iranian populations.[5,11–31]

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We hypothesize that Iranian might have a different rhythm of third molar maturation than that of children in the countries from which the standards were derived. The aim of the present study was the establishment of a radiological database of orthopantomograms from young adults with original Iranian nationality so as to obtain regression formulas for age estimation of Iranian individuals.

2. Material and methods

We examined 1200 orthopantomograms of subjects (males and females between 10 and 27 years of age) taken from the different Clinics of Iran. The criteria for inclusion in the sample were the availability in their clinical records of an orthopantomography of adequate quality, and no history of medical or surgical disease that could affect the presence and development of permanent teeth. At time of radiographic examination, the chronological age of each child was calculated on the basis of the reported date of birth.

Dental development was evaluated according to the scoring method of Demirijian et al., [11] and if necessary imported into Adobe Photoshop CS2 (Adobe Systems Incorporated, San JoseCA). In case of doubt between two adjacent scoring stages, the concerned radiograph was integrated into Adobe Photoshop to blow up the view, to select the mesial and distal enamel cement junction of the involved wisdom tooth and the preceding second molar, to draw a line between them with the line tool, to determine a second line from the middle of the root end perpendicular to the first line detailing the length of the roots of both teeth, and to calculate their proportions. On pluriradicular wisdom teeth the least developed root was examined. All the samples were scored by one well-trained observer.

With an interval of two months, 100 randomly chosen orthopantomograms were graded by a second examiner and re-scored by the main one. To evaluate intra-observer bias, the absolute difference between the first and second scores of the main observer was calculated. Similar calculations were carried out for the scores of the main investigator and the second observer to check inter-observer agreements. Kappa statistics were employed for this purpose. Pearson's correlation coefficient between the developmental scores of different wisdom teeth was calculated. Left–right symmetry in third molar development was evaluated with Student's *t*-test. Multiple regression analysis was performed on the collected database so as to obtain multiple regression formulas for age estimation for males and females separately.

3. Results

The reliability of the method was verified by testing inter- and intra-observer agreement. The kappa value for intra-observer agreement was 0.894, and the 95% CI was 0.887–1.0. The kappa value for inter-observer agreement was 0.689, and the 95% CI was 0.625–0.846. No significant differences were found in mineralization patterns between third molars from either side of the jaw. A high spearman correlation coefficient was found between the right and left third molars in maxillary and mandibular third molars (Table 1). Multiple regression analysis resulted in regression formulas for both females and males enabling dental age estimations taking into account the high correlation between development of left and right third molars (Table 2).

Table 1
Spearman correlation coefficients between developmental scores of third molars.

	UR	UL	LL	LR
UR	1.00000	0.85069	0.87452	1.00000
		<0.0001	<0.0001	<0.0001
	553	438	470	530
UL	0.85069	1.00000	0.94488	0.84613
	<0.0001		<0.0001	<0.0001
	438	467	449	422
LL	0.87452	0.94488	1.00000	0.87107
	<0.0001	<0.0001		<0.0001
	470	449	504	455
LR	1.00000	0.84613	0.87107	1.00000
	<0.0001	<0.0001	<0.0001	
	530	422	455	530

Table 2
Regression formulae on DM method and S.D (standard deviation) for males and females based on the number of present third molar and their location.

DM method				
Male			Female	
Tooth position	S.D	Formula	S.D	Formula
UR/UL/LR/LL	1.46	13.123 + 1.7098 (L) + 0.4567(U)	1.56	10.3456 + 1.2305 (U) + 0.3867(L)
LR/LL	1.65	12.4567 + 1.809(L)	1.69	11.2357 + 1.3421(L)
UR/UL	1.87	12.1132 + 1.3456(U)	1.89	10.4569 + 1.7892(U)

4. Discussion

In recent years, age estimation has become increasingly important, in particular, in determining the age of living persons. From a legal perspective, such age estimates are carried out to determine whether a suspect without legal identification documentation has criminal liability or whether general criminal law in force for adults is to be applied in a particular case. Several studies examined dental age estimation on different populations,[20–26] but the need for a uniform and standardized approach of data collection and analysis are increasing.

In the present study, the database and subsequent regression formulas provide forensic experts at any global location with a specific scientific tool when asked to provide judicial advice concerning the age of majority of a person from Iranian origin. The reliability of the Demirjian et al., [11] method was verified with inter-observer and intra-observer studies. Although agreement between decisions made by the same expert was perfect or substantial according to the six-category system proposed by Landis and Koch [24], the kappa value calculated to measure agreement between decisions made by different experts (reproducibility) can be considered only good or useful for some purposes.

Overall, both inter-observer and intra-observer values were high and similar to those obtained by others.[24,31] These results are same from trends established in previous studies which report a higher percent concordance of right and left sides.[5,14,15] The influence of gender on formation expressed a trend for earlier development in males than females and did not differ from results of previous studies.[15] The higher difference and absolute difference between the first and second scores of the main observer in the upper jaw compared to the lower, point out this overall greater difficulty in scoring maxillary molars. The forensic expert should always consider the ethical justification principles on radiological protection and check the legality of taking radiographs for aging in their jurisdiction. To clarify the influence of ethnicity, Gunst et al., [9] recommended prospective examinations on age estimation, where ethnicity and culture are precisely defined.

Conflict of interest

None.

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Ethical Approval

Informed consent was received from patients involved in this study.

References

1. Kullman L. Accuracy of two dental and one skeletal age estimation method in Swedish addescents. *Forensic Sci Int* 1995;**75**:225–36.
2. Lewis AB, Garn SM. Relationship between tooth formation and other maturational factors. *Angle Orthod* 1960;**30**(2):70–7.
3. Moorrees CF, Fanning EA, Hunt EE. Age variation of formation stages for ten permanent teeth. *J Dent Res* 1963;**42**(6):1490–502.
4. Green LJ. The interrelationships among height, weight and choronological, dental and skeletal ages. *Angle Orthod* 1961;**31**:189–93.
5. Kullman L, Johanson G, Akesson L. Root development of the lower third molar and its relation to chronological age. *Swed Dent J* 1992;**16**:161–7.
6. Nolla CM. The development of permanent teeth. *J Pent Child* 1960;**27**(4): 254–66.
7. Roberts GJ, Parekh S, Petrie A, Lucas VS. Dental age assessment (DAA): a simple method for children and emerging adults. *Br Dent J* 2008;**204**(4):192–3.
8. Schmeling A, Schulz R, Reisinger W, Mühler M, Wernecke KD, Geserick G. Studies on the time frame for ossification of medial clavicular epiphyseal cartilage in conventional radiography. *Int J Legal Med* 2004;**118**:5–8.
9. Gunst K, Mesotten K, Carbonez A, Willems G. Third-molar root development in relation to chronological age: a large sample sized retrospective study. *Forensic Sci Int* 2003;**136**:52–7.
10. Häävikko K. Tooth formation age estimated on a few selected teeth. A simple method for clinical use. *Proc Finn Dent Soc* 1974;**70**:15–9.
11. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. *Hum Biol* 1973;**42**:211–27.
12. Frucht S, Schnegelsberg C, Schulte-Monting J, Rose E, Jonas I. Dental age in southwest Germany. A radiographic study. *J Orofac Orthop* 2000;**61**:318–29.
13. Mincer HH, Harris EF, Berryman HE. The A.B.F.O study of third-molar development and its use as an estimator of chronological age. *J Forensic Sci* 1993;**38**: 379–90.
14. Olze A, Schmeling A, Taniguchi M, Maeda H, Van Niekerk P, Wernecke KD, Geserick G. Forensic age estimation in living subjects: the ethnic factor in wisdom teeth mineralization. *Int J Leg Med* 2004;**118**:170–3.
15. Solari AC, Abramovitch K. The accuracy and precision of third-molar development as an indicator of chronological age in Hispanics. *J Forensic Sci* 2002;**47**: 531–5.
16. Prieto JL, Barberia E, Ortega R, Magana C. Evaluation of chronological age based on third-molar development in the Spanish population. *Int J Legal Med* 2005;**119**:349–54.
17. Engstrom C, Engstrom H, Sagne S. Lower third-molar development in relation to skeletal maturity and chronological age. *Angle Orthod* 1983;**53**:97–106.
18. De Salvia A, Calzetta C, Orrico M, De Leo D. Third mandibular molar radiological development as an indicator of chronological age in a European population. *Forensic Sci Int* 2004;**146**:9–12.
19. Olze A, Taniguchi M, Schmeling A, Zhu BL, Yamada Y, Maeda H, Geserick G. Comparative study on the chronology of third-molar mineralization in a Japanese and a German population. *Leg Med* 2003;**5**:256–60.
20. Olze A, Taniguchi M, Schmeling A, Zhu BL, Yamada Y, Maeda H, Geserick G. Studies on the chronology of third molar mineralization in a Japanese population. *Leg Med* 2004;**6**:73–9.
21. Arany S, Iino M, Yoshioka N. Radiographic survey of third molar development in relation to chronological age among Japanese juveniles. *J Forensic Sci* 2004;**49**:534–8.
22. Orhan K, Ozer L, Orhan AI, Dogan S, Paksoy CS. Radiographic evaluation of third-molar development in relation to chronological age among Turkish children and youth. *Forensic Sci Int* 2007;**165**:46–51.
23. Melsen B, Wenzel A, Miletic T, Andreasen J, Vagn-Hansen PL, Terp S. Dental and skeletal maturity in adoptive children: assessments at arrival and after one year in the admitting country. *Ann Hum Biol* 1986;**13**:153–9.
24. Dhanjal KS, Bhardwaj MK, Liversidge HM. Reproducibility of radiographic stage assessment of third-molars. *Forensic Sci Int* 2006;**159**:74–7.
25. Uzamis M, Kansu O, Taner TU, Alpar R. Radiographic evaluation of third-molar development in a group of Turkish children. *ASDC J Dent Child* 2000;**67**:136–41.
26. Thorson J, Hagg U. The accuracy and precision of the third mandibular molar as an indicator of chronological age. *Swed Dent J* 1991;**15**:15–22.
27. Bhat VJ, Kamath GP. Age estimation from root development of mandibular third molars in comparison with skeletal age of wrist joint. *Am J Forensic Med Pathol* 2007;**28**:238–41.
28. Meinl A, Tangl Huber C, Maurer B, Watzek G. The chronology of third molar mineralization in the Austrian population – a contribution to forensic age estimation. *Forensic Sci Int* 2007;**169**:161–7.
29. Levesque GY, Demirjian A, Tanguay R. Sexual dimorphism in the development, emergence and agenesis of the mandibular third molar. *J Dent Res* 1981;**60**: 1735–41.
30. Lee SE, Lee SH, Lee JY, Park HK, Kim YK. Age estimation of Korean children based on dental maturity. *Forensic Sci Int* 2008;**178**(2–3):125–31.
31. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;**33**(1):159–74.